Eye structure of externally eyeless Grylloblattids (Insecta,Notoptera)

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Eye Structure of Externally Eyeless Grylloblattids (Insecta, Notoptera)*

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Synopsis

Eye structure of externally eyeless *Galloisiana nipponensis* is investigated using light and scanning electron microscopic techniques. The cornea and retinula cells in an ommatidium are formed but only eye pigment was lacking.
Key words: Notoptera, *Galloisiana*, compound eye, eyeless.

Introduction

The notopteran insects are apterous, and have small compound eyes but no dorsal ocelli. In *Galloisiana nipponensis* (CAUDELL et KING) the eyes are composed of only about forty ommatidia loosely arranged (GOKAN et al., 1979). However, the number of ommatidia comprising an eye varies according to each individual and some specimens externally lack the eye (GOKAN et al., 1979). These specimens can be collected not only from caves but moist and cool places in mountainous zones of Japan, also. In the present study I investigated and have described eye structure of these externally eyeless Grylloblattids using light and scanning electron microscopic techniques.

Materials and Methods

Male adult which have externally obscure and weakly pigmented compound eyes, were obtained from under stones in Mt. Gassan of Yamagata Prefecture; female adults and 7th nymphal instars which display the externally eyeless feature, were collected from under stones in Jyumonji-pass of Saitama Prefecture and inToyohashi City of Aichi Prefecture. After fixation their heads were split in half and one of each pair was embedded in paraffin, sectioned at 5 μm, and stained with Delafield's haematoxylin and eosin for observation by

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light microscopy. For scanning electron microscopy (SEM), the remaining eyes in each case were dehydrated through an ethyl alcohol/isoamyl acetate series, and dried by critical point method, and coated with gold-palladium. Specimens were examined with a Jeol-35 SEM.

Results and Discussion

As described above, the eyes of *Galloisiana nipponensis* are composed of only about forty ommatidia loosely arranged as seen in Fig. 1A. However, some of specimen have externally obscure eye or a reduced number of ommatidia as in Fig. 1B. In extreme cases the compound eyes are externally lacking altogether (Fig. 1C, D).

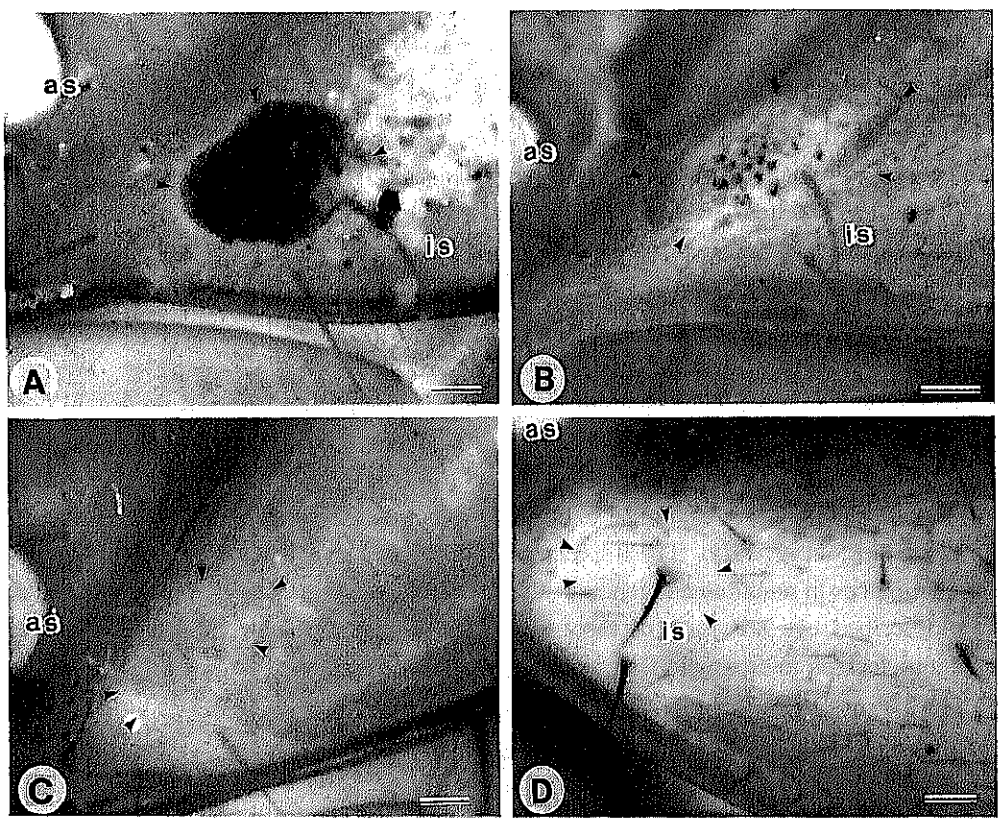

Fig. 1. Compound eyes of *Galloisiana nipponensis* (arrows show site of compound eye).
A. Normal compound eye. B. Eye with decreasing number of ommatidia. C. Externally eyeless specimen with interommatidial setae absent. D. Externally eyeless specimen with setae. as, antennal socket; is, interommatidial setae. Scales=0.1mm.

The surface structure of the eye area of an externally eyeless individual is shown in Fig. 2A. The area under devate was elliptical with convex outer surface and displayed three setae, two thin and one thick (absent). Facets were also identifiable but they were less clear than those of normal-eyed individuals (Fig. 2B). The whole surface area of the eye region and the general surface were covered with numerous arabesque-like structures considered to represent waxy substances (GOKAN et al., 1979).

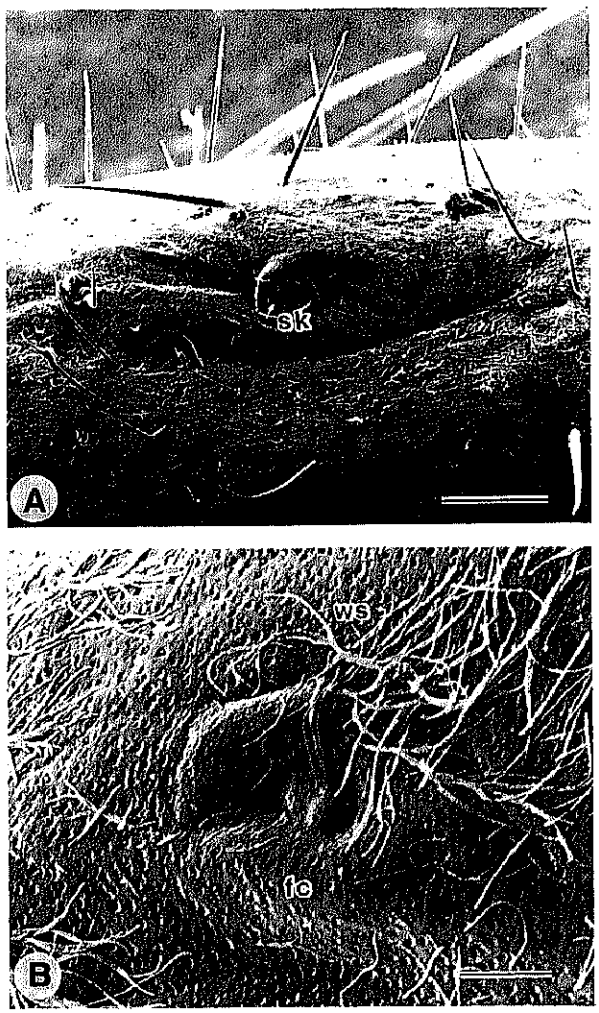

Fig. 2. Scanning electoron micrographs (SEM) of eye region of externally eyeless individuals. Eye area (A) and facet (B).
A. Whole eye at lower magnification showing elliptical, convex area having ommatidia and setae, with one thick setae absent. Up is dorsal, left is anterior direction. Scale=0.1mm. B. Cornea, at high magnification, covered with arabesque-like presumably waxy secretions (ws). Scale=5μm. fc, facet; sk, socket of interommatidial seta.

Corneal lenses are present but of a biconvex form that is less distinct than compared with those of normal-eyed individuals. The retinula cells and pigment cells of both types (externally reduced eye and eyeless individuals) are completely formed (Fig.3). However, the total amount of pigment grains per ommatidium is different among the two types, namely, the pigment grains in the retinula cells and pigment cells in externally reduced eyes or the obscure eye are few, but still more numerous than those of an ommatidium of an externally eyeless individuals where pigment was completely lacking (Fig. 3)

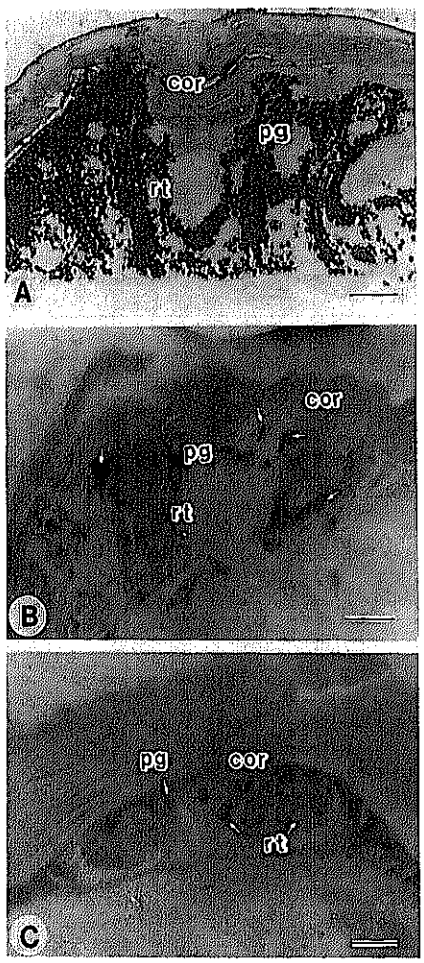

Fig. 3. Light micrographs of the eyes. Longitudinal sections through several ommatidia.
A. Normal eye, showing each ommatidium contains abundant pigment grains in retinula and pigment cells. B. Externally obscure eye, showing a few pigment grains being scattered (arrows) in an ommatidium. C. Eye region of externally eyeless individual, showing total lack of pigment grains in the ommatidium. Scales=20μm. cor, cornea ; pg, pigment cell ; rt, retinula cell.

As a result of the present observation, the existence of retinula cells and pigment cells became clear in both types. Presumably the ommatidial components of the externally eyeless individuals are completely formed but only the eye pigment was lacking. However, in the present species any influences of the lack of pigment grains on the visual system and differences in the habits or behaviour between the externally eyeless and normal-eyed individuals were not observed. Though there are exceptions (MEYER-ROCHOW and LIDDLE, 1988), generally, animals lacking eyes are well known in cave dwellers. This includes arthropods with compound eyes (MEYER-ROCHOW and JUBERTIE-JUPEAU, 1983, 1987). It is trace that in Grylloblattids specimens lacking eyes are often collected in Japanese and Korean limestone caves (e.g. NAMKUNG, 1982). It would seem neccessary, however, to confirm that the eyes of such troglobitic specimens are or are not the same structurally compared with those of the present observation. Furthermore, other details like cell organelles will have to be elucidated in comparisons of the microstructure of ommatidia belonging to animals occupying different habitats.

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